

Claims

1 Sub B' 1. A method for encoding a sequence of video  
2 frames comprising for each frame of the sequence of  
3 video frames:

4 (a) encoding said frame employing at least  
5 one controllable parameter; and

6 (b) adapting said encoding (a) of said  
7 frame when said frame is a still frame, said  
8 adapting including adjusting said at least one  
9 controllable parameter employed in encoding said  
10 still frame to minimize pulsation artifacts  
11 between still frames of a sequence of still  
12 frames within said sequence of video frames,  
13 wherein said still frame comprises one still  
14 frame of said sequence of still frames.

1 2. The method of claim 1, further comprising  
2 determining whether said frame comprises said still  
3 frame.

1           3.    The method of claim 2, wherein each frame  
2 of the sequence of video frames comprises a plurality  
3 of pixels, and wherein each pixel of each frame  
4 comprises a multi-bit value and said determining  
5 comprises:

6                   determining for a current frame (k+1) of  
7 the sequence of frames a summation statistic  
8 (PIX-SUM<sub>k+1</sub>) derived from said multi-bit values  
9 of the plurality of pixels of the current frame;

10                   determining a summation statistic (PIX-  
11 SUM<sub>k</sub>) derived from the multi-bit values of the  
12 plurality of pixels of a prior frame (k)  
13 preceding the current frame (k+1) in the  
14 sequence of video frames; and

15                   determining whether:

16                   
$$| \text{PIX-SUM}_k - \text{PIX-SUM}_{k+1} | < X$$

17                   where X is a predefined value representative of  
18 a still frame.

1           4.    The method of claim 3, wherein said  
2   determining further comprises:

3                   determining an accumulated absolute  
4   difference derived from adjacent pixels of said  
5   plurality of pixels of the current frame (PIX-  
6   DIFF<sub>k+1</sub>);

7                   determining an accumulated absolute  
8   difference derived from adjacent pixels of said  
9   prior frame (PIX-DIFF<sub>k</sub>); and

10                  determining whether:

11                            $|PIX-DIFF_k - PIX-DIFF_{k+1}| < Y$

12                   wherein Y is a predefined value, and  
13   wherein said current frame is determined to  
14   comprise said still frame if both  $|PIX-SUM_k -$   
15    $PIX-SUM_{k+1}| < X$  and  $|PIX-DIFF_k - PIX-DIFF_{k+1}| < Y$   
16   are true.

1           5.    The method of claim 4, wherein said  
2   determining further comprises dividing the current  
3   frame and the prior frame into z corresponding  
4   regions, and wherein said determining comprises  
5   determining whether for each of said z corresponding  
6   regions:

7                            $|PIX-SUM_{kz} - PIX-SUM_{(k+1)z}| < X.$

1           6.    The method of claim 5, wherein  $X=256$ ,  
2     $Y=256$ , and  $z \geq 4$ , and wherein said four corresponding  
3    regions of said current frame and said prior frame  
4    comprise four horizontal bands.

1           7.    The method of claim 2, further comprising  
2    determining whether said frame comprises a reference  
3    (I) still frame for said sequence of still frames and  
4    if so increasing a target bitrate to be used by said  
5    encoding (a) to encode said reference still frame.

1           8.    The method of claim 7, wherein said  
2    increasing of the target bitrate for said reference  
3    still frame comprises detecting a subsequent B or P  
4    still frame in said sequence of still frames and  
5    moving target bits from said subsequent B or P still  
6    frame to said reference still frame.

1           9.    The method of claim 8, wherein said moving  
2    of target bits comprises moving fifty percent of  
3    target bits for encoding said subsequent B or P still  
4    frame to encoding of said reference still frame.

1           10.   The method of claim 2, wherein each frame  
2    comprises a plurality of macroblocks, and said method  
3    further comprises setting a zero motion vector mode  
4    ON upon determining that said frame comprises a still  
5    frame, and determining a predictive error for each  
6    macroblock of said still frame, and when said  
7    predictive error is less than a predetermined value,  
8    setting said predictive error to zero making said  
9    macroblock a skip macroblock.

1           11. The method of claim 10, further comprising  
2     calculating a quantization level (QL) for said skip  
3     macroblock for use in encoding said macroblock, and  
4     comparing the calculated quantization level (QL) to  
5     an average quantization level of a reference still  
6     frame ( $Av\ QL_{ref}$ ) of said sequence of still frames and  
7     replacing said calculated quantization level with  
8     said average quantization level of said reference  
9     still frame when said calculated quantization level  
10    is less than said average quantization level of said  
11    reference still frame.

1           12. The method of claim 1, wherein when said  
2     frame comprises a still frame, said adapting (b)  
3     comprises defining a plurality of macroblocks in said  
4     still frame as skip macroblocks, and maintaining a  
5     minimum quantization level for encoding (a) of each  
6     skip macroblock of said still frame.

1           13. The method of claim 12, wherein said  
2     adapting (b) comprises maintaining said minimum  
3     quantization level for each skip macroblock of said  
4     still frame to be an average quantization level of a  
5     reference still frame ( $Av\ QL_{ref}$ ) for said sequence of  
6     still frames.

Sub B2

14. The method of claim 2, wherein said frame comprises a plurality of macroblocks, and wherein said determining comprises determining whether said frame comprises a motion frame, and when so, said method further comprises for each of at least some macroblocks of said motion frame:

(i) determining whether said macroblock comprises a still macroblock;

(ii) encoding said macroblock employing at least one controllable parameter; and

(iii) adapting said encoding of said macroblock when said determining (i) determines said macroblock to be said still macroblock, said adapting including adjusting said at least one controllable parameter employed in encoding said still macroblock to minimize pulsation artifacts between corresponding still macroblocks of adjacent frames in said sequence of video frames.

1           15. The method of claim 14, wherein said  
2     adapting of said encoding comprises confirming that  
3     said still macroblock is other than an edge  
4     macroblock and is a non-intra macroblock, and that  
5     said frame comprises a P frame, and when confirmed,  
6     said method further comprises: determining that a  
7     motion vector for said still macroblock is zero and a  
8     macroblock difference (MBD) value is less than a  
9     predefined value, and when true, encoding said still  
10    macroblock as a skip macroblock and assigning a  
11    minimum quantization level to said skip macroblock.

1           16. The method of claim 15, wherein said  
2     assigning of the minimum quantization level comprises  
3     assigning an average quantization level for a  
4     reference frame for said P frame as quantization  
5     level for said skip macroblock.

1           17. The method of claim 14, wherein said  
2     adapting of said encoding comprising confirming that  
3     said still macroblock is other than an edge  
4     macroblock and is a non-intra macroblock, and that  
5     said frame comprises a B frame, and when confirmed,  
6     said method further comprises: determining that a  
7     motion vector for said still macroblock is equal to a  
8     motion vector of a previous macroblock in the B frame  
9     and that a macroblock difference (MBD) value is less  
10    than a predefined value, and if so, then encoding  
11    said still macroblock as a skip macroblock and  
12    assigning a minimum quantization level to said skip  
13    macroblock.

1           18. The method of claim 17, wherein said  
2     assigning of the minimum quantization level comprises  
3     assigning an average quantization level for a  
4     reference frame for said B frame as quantization  
5     level for said skip macroblock.



1  
2 <sup>3</sup> 19. A method for encoding a frame of a sequence  
3 of video frames, said frame having a plurality of  
4 macroblocks, said method comprising for each of at  
5 least some macroblocks of said plurality of  
macroblocks:

6 (a) encoding said macroblock employing at  
7 least one controllable parameter; and

8 (b) adapting said encoding of said  
9 macroblock when said macroblock is a still  
10 macroblock, said adapting including adjusting  
11 said at least one controllable parameter  
12 employed in encoding said still macroblock to  
13 minimize pulsation artifacts between  
14 corresponding still macroblocks of adjacent  
15 frames in said sequence of video frames.

1 20. The method of claim 19, further comprising  
2 determining whether said macroblock comprises said  
3 still macroblock.

1 21. The method of claim 19, wherein said  
2 adapting of said encoding comprises encoding said  
3 still macroblock as a skip macroblock and assigning a  
4 minimum quantization level to said skip macroblock.

1 22. The method of claim 20, wherein said  
2 assigning of the minimum quantization level comprises  
3 assigning an average quantization level of a  
4 reference frame to said frame as said minimum  
5 quantization level for said still macroblock.

Sub B4

23. A system for encoding a sequence of video frames comprising:

a pre-encode processing unit, said pre-encode processing unit comprising:

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4  
5  
6  
7  
8

a statistics measurement unit for use in determining whether a current frame of the sequence of frames comprises a still frame;

a control unit for modifying at least one controllable parameter employed in encoding said still frame to minimize pulsation artifacts between still frames of a sequence of still frames when said statistics measurement unit determines said current frame to comprise said still frame; and

an encoding engine for encoding said current frame of the sequence of video frames using the at least one controllable encode parameter set by said pre-encode processing unit.

24. The system of claim 23, wherein said statistics measurement unit comprises means for determining whether said current frame comprises a reference still frame, and if so, said control unit comprises means for increasing a target bitrate used by the encoding engine to encode said reference still frame.

1           25. The system of claim 24, wherein said means  
2 for increasing said target bitrate comprises means  
3 for transferring target bits from a subsequent still  
4 frame in a sequence of still frames to said reference  
5 still frame, said reference still frame also being in  
6 said sequence of still frames.

1           26. The system of claim 23, wherein each frame  
2 of said sequence of video frames comprises a  
3 plurality of macroblocks, and wherein said control  
4 unit of said pre-encode processing unit further  
5 comprises means for setting zero motion vector mode  
6 ON upon determining that said frame comprises a still  
7 frame, and means for determining a predictive error  
8 for each macroblock of said still frame, and for each  
9 macroblock of said still frame for setting its  
10 predictive error to zero making said macroblock a  
11 skip macroblock when its determined predictive error  
12 is less than a predetermined value representative of  
13 a still macroblock.

1           27. The system of claim 26, wherein said  
2 control unit further comprises means for maintaining  
3 a minimum quantization level for encoding each skip  
4 macroblock of said still frame.

1           28. The system of claim 27, wherein said means  
2 for maintaining comprises means for maintaining said  
3 minimum quantization level for each skip macroblock  
4 of said still frame at an average quantization level  
5 of a reference still frame ( $Av\ QL_{ref}$ ) for said  
6 sequence of still frames.

1           29. The system of claim 23, wherein each frame  
2 of the sequence of video frames comprises a plurality  
3 of pixels, and wherein each pixel of each frame  
4 comprises a multi-bit value, and said statistics  
5 measurement unit comprises means for:

6           determining for a current frame (k+1) of  
7 the sequence of frames a summation statistic  
8 (PIX-SUM<sub>k+1</sub>) derived from said multi-bit values  
9 of the plurality of pixels of the current frame;

10           determining a summation statistic (PIX-  
11 SUM<sub>k</sub>) derived from the multi-bit values of the  
12 plurality of pixels of a prior frame (k)  
13 preceding the current frame (k+1) in the  
14 sequence of video frames; and

15           determining whether:

16           
$$|\text{PIX-SUM}_k - \text{PIX-SUM}_{k+1}| < X$$

17           where X is a predefined value representative of  
18 a still frame.



1           32. The system of claim 31, wherein said means  
2     for adapting comprises means for confirming that said  
3     still macroblock is other than an edge macroblock and  
4     is a non-intra macroblock, and that said frame  
5     comprises a P frame, and wherein said control unit  
6     further includes means for determining that a motion  
7     vector for said still macroblock is zero and a  
8     macroblock difference (MBD) value is less than a  
9     predefined value, and when true, said encoding engine  
10    further comprises means for encoding said still  
11    macroblock as a skip macroblock having a minimum  
12    quantization level defined by a quantization level of  
13    a reference frame for said P frame.

1           33. The system of claim 31, wherein said means  
2     for adapting comprises means for confirming that said  
3     still macroblock is other than an edge macroblock and  
4     is a non-intra macroblock, and that said frame  
5     comprises a B frame, and wherein said control unit  
6     further comprises means for determining that a motion  
7     vector for said still macroblock is equal to a motion  
8     vector of a previous macroblock in the B frame and  
9     that a macroblock difference (MBD) value is less than  
10    a predefined value, and when true, said encoding  
11    engine further comprises means for encoding said  
12    still macroblock as a skip macroblock having a  
13    minimum quantization level to said skip macroblock,  
14    defined by a quantization level of a reference frame  
15    for said B frame.

1 *Sub B<sup>6</sup>* 34. A system for encoding a macroblock of a  
2 plurality of macroblocks of a frame in a sequence of  
3 video frames, said system comprising:

4 an encoding engine for encoding said  
5 macroblock of said frame using at least one  
6 controllable encode parameter; and

7 *CH* means for adapting said encoding of said  
8 macroblock when said macroblock is a still  
9 macroblock, said adapting including means for  
10 adjusting said at least one controllable  
11 parameter employed in encoding said still  
12 macroblock to minimize pulsation artifacts  
13 between corresponding still macroblocks of  
14 adjacent frames in said sequence of video  
15 frames.

1 35. The system of claim 34, further comprising  
2 means for determining whether said macroblock  
3 comprises said still macroblock.

1 36. The system of claim 35, wherein said means  
2 for adapting of said encoding comprises means for  
3 adjusting encoding of said still macroblock to encode  
4 said still macroblock as a skip macroblock and to  
5 encode said skip macroblock with a minimum  
6 quantization level defined by a quantization level of  
7 a reference frame to said frame having said still  
8 macroblock.





1           38. The computer readable program code means of  
2 claim 37, wherein said computer readable program code  
3 means for causing a computer to affect determining  
4 comprises computer readable program code means for  
5 causing a computer to affect determining whether said  
6 frame comprises a reference (I) still frame for said  
7 sequence of still frames, and when so, said computer  
8 readable program code means for causing a computer to  
9 affect adapting comprises computer readable program  
10 code means for causing a computer to affect  
11 increasing a target bitrate to be used by said  
12 encoding to encode said reference still frame by  
13 moving target bits from at least one subsequent still  
14 frame of said sequence of still frames to said  
15 reference still frame.

1           39. The computer readable program code means of  
2 claim 38, wherein each frame of said sequence of  
3 video frames comprises a plurality of macroblocks,  
4 and wherein said computer readable program code means  
5 for causing a computer to affect adapting comprises  
6 computer readable program code means for causing a  
7 computer to affect setting a zero motion vector mode  
8 ON upon determining that said frame comprises said  
9 still frame, and for determining a predictive error  
10 for each macroblock of said still frame, and when  
11 said predictive error is less than a predetermined  
12 value, for setting said predictive error to zero  
13 making said macroblock a skip macroblock.



Sub B8

41. The computer readable program code means of  
claim 37, wherein said frame comprises a plurality of  
macroblocks, and wherein said computer readable  
program code means for causing a computer to affect  
determining comprises computer readable program code  
means for causing a computer to affect determining  
whether said frame comprises a motion frame, and when  
so, said computer readable program code means further  
comprises for each of at least some macroblocks of  
said motion frame:

computer readable program code means for  
causing a computer to affect determining whether  
said macroblock comprises a still macroblock;

computer readable program code means for  
causing a computer to affect encoding said  
macroblock employing at least one controllable  
parameter; and

computer readable program code means for  
causing a computer to affect adapting said  
encoding of said macroblock when said macroblock  
comprises said still macroblock, said adapting  
including adjusting said at least one  
controllable parameter employed in encoding  
said still macroblock to minimize pulsation  
artifacts between corresponding still  
macroblocks of adjacent frames in said sequence  
of video frames.

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